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TECHNICAL NEWS BULLETIN
OF THE BUREAU OF STANDARDS

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STEVENSON CREEK (CALIF.) ARCH DAM

The Bureau of Standards has cooperated with the Committee on Arch Dam Investigation of the Engineering Foundation in the construction and testing of a concrete arch dam in the mountains near Fresno, Calif. The electric telemeter developed by McCollum and Peters of the bureau was used in the tests and made possible the measurement of strains with a high degree of precision at places entirely inaccessible by other means. Ideas for other instruments partially developed at the bureau were furnished to the committee, and after further development instruments based on these ideas were successfully applied in the work. W. A. Slater, of the bureau's staff, spent approximately two years in California in charge of the test and in the preparation of the report.

No further tests have been made since the note published in Technical News Bulletin No. 117 (January, 1927). However, the dam has undergone severe tests occasioned by floods since the time that the former news item was prepared. A flood which destroyed all the observation platforms and caused the choking of the undersluice, filled the reservoir with rock, sand, and silt to an average depth of about 40 feet at the upstream face of the dam. With this débris against the dam the water filled the reservoir and at times rose to a height of

about 3 feet above the crest of the dam. From November, 1926, to July, 1927, and again during the present winter the reservoir has been full, and a small amount of water has been running over the top of the dam. The only observed effects produced by this unexpected pressure of débris and water have been a slight extension of the cracks near the bottom of the dam, which occurred during a previous load test, the formation of an additional crack near the bottom, and a small increase in the deflection of the dam. At the time of the latest examination (July 13, 1927) all other cracks remained about as they appeared in October, 1926.

The test has yielded results which give direct information on the temperatures in the concrete and on strains, stresses, and deflections in the dam. The results also afford a basis for comparison with the stresses and deflections as computed by current methods of design. There was reasonably good agreement with the computed stress at approximately the mid-height of the dam, but at the top the agreement was poor. Results of tests on a celluloid model of the dam at Princeton University agree so well with the results from the actual structure that added confidence is felt in the use of models in designing arch dams. The Bureau of Reclamation is building at the University of Colorado, Boulder, Colo., a concrete model of the Stevenson Creek Dam, which will be tested for comparison with the Stevenson Creek Dam, also a model of the Gibson Dam, which is to be built in Montana and which will be about 900 feet long and 165 feet high. The model will be tested as a check on the design of the dam as made by the Bureau of Reclamation.

The highest temperature observed in the concrete was about 47° C. (117° F.). This occurred at an elevation of about 4 feet within about 24 hours after the placing of the concrete. The dam is about 6 feet thick at this elevation. The decrease from maximum temperature was rapid and an equilibrium with the air temperature was reached in about 10 days.

At about 12 feet above its lowest point the dam cracked loose from the abutments within a few days after placing the concrete at that elevation. Before the beginning of the load tests the dam had cracked loose from the abutments on the upstream face most of the way from this elevation to the top of the dam. On the downstream face the cracking loose from the abutment extended from the top of the dam downward to about the 30-foot elevation. At the bottom of the dam under a head of water between 30 and 40 feet there was a separation from the foundation at the upstream face. With a head of a little less than 50 feet a vertical crack occurred on the center line of the dam extending downward about 11 feet. This crack extended entirely through the thickness of the dam, but it was wider on the downstream than on the upstream face. The crack closed as the water was raised to the top of the dam. With later loadings the crack extended somewhat until, within a short time, it had extended downward about 20 feet. The loading due to the flood water and débris seemed to have no further effect on this crack.

With a head of 60 feet a vertical crack formed on the downstream face of the dam at the center line from about 2 inches above the bottom to a height of 9 feet. Later it extended to a height of 13 feet. The telemeter readings indicated that this crack did not extend through to the upstream face.

Leakage through the dam was small at all times. With heads less than 50 feet it showed up merely as moist spots at a few places not over 8 inches in diameter. With higher heads and long continued pressure some of the construction joints opened slightly, permitting some increase in the leakage.

The highest stress indicated by the measured strains was a compression of about 1,100 lbs./in.^{2}. This stress was found at a single point. Everywhere else the stress was considerably lower. The compressive strength of the concrete at this age, as indicated by tests of 6 by 12 inch cylinders 3 months old, was about 2,800 lbs./in.^{2}.

The strains, measured by different methods, were in fair agreement with each other, and from these strains it was possible to determine with reasonably good approximation the amount and distribution of the loads carried by arch action and by bending in both the vertical and horizontal elements. The agreement of the sum of the loads so determined with the total water pressure forms a check on the approximate correctness of the results.

WORKABILITY OF CONCRETE

A summary of the study of the methods for measuring the workability of concrete which has been conducted at the bureau was presented at the convention of the American Concrete Institute at Philadelphia, February 28 to March 1.

The plastic properties of neat cement pastes were first studied, by measurements of the velocity of a ball pulled through the paste. This apparatus gave data of interest but could not be applied to the study of the workability of concrete. Next, a study of the separation of the concrete on the flow table was made. After flowing the concrete was divided into two equal areas by two concentric circular cutters. The volume and weight of aggregate coarser than the No. 4 sieve in each portion were measured, and the workability figure calculated as a function of these measurements. Several shapes of flow table and heights of drop were used. There was an indication that the best results were obtained with the flat top table operated with a one-sixteenth inch drop. This method was not, however, found completely satisfactory since the influence of mixing time could not be determined. The next method which was used measured the internal resistance to shear of the concrete by the deformable cylinder, as described in Technical News Bulletin No. 114, October, 1926. The results obtained with this method were encouraging but did not show a marked difference in workability of lean concrete mixes. The final study was made with a modification of the Pearson and Hitchcock penetration rod apparatus. This apparatus was modified by making each drop of the weight a constant and then by increasing the number of rods from 1 to 3. This apparatus has given the most satisfactory index of workability thus far obtained.

The principal results obtained from the tests may be summarized as follows:

1. The workability as determined by the separation of the concrete on the flow table was not satisfactory for several reasons. The individual measurements varied too greatly, the measurements on mixes of different proportions did not show markedly different results, and the personal element also entered too markedly into the tests.

2. The deforming cylinder apparatus did not measure the workability of lean mixes of different proportions distinctly and conclusively, nor was the test sensitive enough to measure the effect of increase in the mixing time upon the workability.

3. The modification of the penetration rod apparatus by driving in the rod by a falling weight instead of by the inertia of the rod when the whole apparatus was dropped has eliminated the compacting of the aggregates and, together with lightening the rods and driving weight, using three rods instead of one, and the use of a larger mold, has increased the precision of the tests. This apparatus is capable of measuring the influence of increased mixing time upon the workability and measures the difference in workability of lean mixes with different gradations.

The studies are being continued.

NATURAL PROTECTIVE CRUST ON STONE

A theory which has long been held by stone producers and many others concerned with the weathering of natural stone is that when the material is exposed to the weather a protective skin or crust is formed which tends to overcome the effect of the elements. For this reason it is often stated that cleaning methods, such as sand-blasting or any others which remove some of the surface of masonry, will destroy this natural protective coating and ma-

terially shorten the endurance of the stone.

Some weathered samples of limestone were recently subjected to experiments at the bureau to determine if such a protective crust actually exists. One sample was a window sill from a building about 40 years old and another was a sill from a building about 30 years old. The two sets of specimens were prepared from each sample, one set having as one surface the weathered face of the stone as removed and another having as one surface a face cut 4 inches below the weathered face. These were tested for permeability, absorption, and abrasive hardness. Permeablity tests were made under a water pressure of 100 lbs./in.^{2}, and absorption tests were made in such a way that the water was absorbed only by capillary forces through one face of the slabs. In all tests the results indicated that stone near the weathered face was more absorptive, more permeable to water, and softer than the material 4 inches below this surface. The permeability of the specimens cut at the exposed face of the sample 40 years old was about twice as great as the permeability of specimens cut from the interior. Hardness tests indicated that the weathered surface was abraded about 50 per cent faster than the unweathered stone.

"TRUE" DENSITY OF SEVERAL LIMESTONES USED IN THE MANUFACTURE OF LIME

In an investigation at the bureau on improvement in the manufacture of lime products it has been found necessary to make a study of some of the physical properties of several limestones. The properties considered were density, porosity, and crystal size. The careful determination of these properties, it is hoped, may, on completion of the work, give some index as to the optimum conditions to be imposed upon stone of different types in order to yield the most satisfactory products.

Density determinations have been made on 12 samples of stone, and in view of the limited amount of data of this nature available the results are herewith presented. The methods used were as follows: The rock samples were reduced to pass a No. 200 sieve. A weighed portion of the ground sample was placed in a calibrated picnometer which was then evacuated to a pressure of 10 mm of mercury for two hours. While the picnometer was still evacuated kerosene was added until the sample was submerged in that liquid. The picnometer was then filled to the calibration mark with kerosene at 25° C. and weighed. The density of the kerosene was determined both under atmospheric conditions and for a period of one-half hour in vacuuo. No appreciable difference was observed in the kerosene density under the two conditions. The above procedure was, therefore, considered sufficiently accurate, especially in view of the fact that the kerosene was exposed to vacuum over the sample for only 2 to 5 minutes.

The following table gives the results obtained:

Sample No.	Type	Locality	"True" density
1	High Ca	Missouri	2.788
2	do	Virginia	2.760
3	do	Ohio	2.772
4	do	West Virginia	2.795
5	do	do	2.759
6	Mg	Ohio	2.858
7			
8	Mg	Maine	2.882
9	High Ca	Washington	2.861
10	Dolo	Ohio	2.694
11	do	do	2.883
12	Mg	Pennsylvania	2.844
13	High Ca	Vermont	2.877

CLEANERS FOR TERRA COTTA

In connection with its study of the physical properties of architectural terra cotta, the bureau has investigated the behavior of several cleaners for this material. It was found that sodium hydrosulphite cleaned terra cotta very well and did not corrode the glaze. Fluosilicic acid also cleaned the terra cotta in a satisfactory manner and attacked the glaze but slightly. Trisodium phosphate proved to be a good cleaner on standard finishes, but was not very suc-

cessful on glazed finishes. Soap powder was only a fair cleaner and has a tendency to scour, and thus roughen the glazed surfaces. Hydrochloric acid, also, is only a fair cleaner and has a slight corrosive effect on the glaze. Hydrofluoric acid removes the dirt better than any cleaner tried, but also etches the surface finish very badly, and therefore its use for cleaning terra cotta must be condemned.

INDUSTRIAL RESEARCH AND THE BRICK INDUSTRY

On February 17 the director of the bureau addressed the annual meeting in Washington of the Common Brick Manufacturers Association of America. Doctor Burgess pointed out the value of technical research in the brick industry, and called attention to the fact that, although this is one of the most ancient industries with an enviable record extending back for thousands of years, but little is known of the underlying scientific principles which control the quality of the product. "A common brick is a very uncommon thing," said Doctor Burgess. "It is a very complex physical mixture of several chemical constituents whose properties are dependent on size of particles, the process of mixing, the mechanical and thermal treatments." However, he explained that progress is being made in the solution of some of the important problems through the hearty cooperation of the association and the Bureau of Standards. Kiln processes are being studied, the strength, fire resistance, and sound transmission of brick walls have been determined, and the efficiency of brick-making machines is being measured. Many of these investigations have been described and progress recorded in previous numbers of this bulletin.

A special trip through the bureau's laboratories was arranged on February 16, so that the members of the association were given an opportunity to see some of the research work at first hand. An interesting sight was a half brick supporting a load of 100,000 pounds dead weight. A compression test of an 8-inch brick wall in the 10,000,000-pound testing machine was also witnessed.

The personal contacts established through a meeting of this kind are certain to have important beneficial effects on the industry and the bureau.

ARTIFICIAL VITRIFYING AGENTS FOR CERAMIC BODIES

An investigation is being conducted at the Columbus branch of the bureau to determine the effect of artificial vitrifying agents in ceramic bodies. It is hoped by this investigation to lower the maturing temperature of a given body or to affect a greater vitrification and corresponding translucency at the same temperature. After a preliminary survey of the data available, the problem was attacked by choosing certain eutectic mixtures which deform below cone 5, 1,229° C. (2,245° F.). These eutectics, prepared as fritted glasses, constitute the source of the artificial vitrifying agents employed in the bodies.

The eutectics between the following materials were chosen: Feldspar-steatite, albite-calcite, sodium silicate-calcium silicate, albite-microcline, albite-magnesite, barium oxide-B_2O_3, calcium oxide-B_2O_3, barium silicate-sodium silicate, sodium silicate-magnesium silicate, microcline-albite-$CaO.Al_2O_3.SiO_2$, K_2O-SiO_2, K_2O-Al_2O_3-SiO_2, Na_2O-SiO_2, Na_2O-SiO_2-Al_2O_3, BaO-Al_2O_3-SiO_2, Na_2O-B_2O_3-SiO_2, K_2O-B_2O_3-SiO_2, Na_3AlF_6-Al_2O_3.

As a preliminary test, it was decided to make a cone deformation study which would also serve as a key to the degree of vitrification of the fritted bodies. Hence, the fritts were incorporated in a basic porcelain body composed of 16 per cent feldspar, 10 per cent No. 4 Kentucky ball clay, 35 per cent English china clay, and 39 per cent flint. Those fritts containing feldspar as one ingredient were added in amounts of 1, 3, and 5 per cent, all others being added in amounts of 10, 25, and 40 per cent.

These cones were fired in a downdraft, gas-fired test kiln to cone 8. A brief summary of the first burn shows that complete deformation is obtained in 20 compositions containing 25 and 40

per cent fritt, between the temperature of 1,060° C. (1,940° F.) (cone 05–04) and 1,290° C. (2,335° F.) (cone 8). In 10 other compositions containing 10 per cent fritt, complete vitrification was obtained, as evidenced by a much glassier texture and lower per cent absorption than the standard body chosen.

It is evident, therefore, that the amount of body flux used can be diminished below 10 per cent, and that vitrification can be obtained at a temperature lower than that normally required. The fluxes, and the minimum amounts necessary to produce these desired properties, will be determined along with the effect these vitrifying agents may have on the physical properties of the given body.

CRAZING OF GLAZES CAUSED BY PERMANENT INCREASES IN SIZE OF CERAMIC BODIES

The bureau, in cooperation with the National Terra Cotta Society, is investigating the causes and remedies for delayed crazing of glazes for ceramic products and has developed a proposed method for testing glazes for this type of crazing.

In general, there are two types of crazing which develop on glazed ceramic wares. One type is apparent upon removal of the ware from the kiln or it may develop a short time after removal. The cause of this type of crazing is well understood. It develops when a glaze contracts more than the body in cooling from the temperature at which the glaze becomes rigid down to room temperatures. Obviously, this type of crazing may be prevented by selecting a glaze whose coefficient of expansion is the same as, or slightly less than, that of the body, so that the glaze contracts the same amount or slightly less than the body during cooling.

The second type, called "delayed crazing," may first develop a year or more after the ware has been fired, and heretofore its cause has not been well understood. It was thought at first that delayed crazing was the result of tension strains in the glaze which caused it to fail after a lapse of time, since these strains would produce fatigue of the glaze. However, upon investigation it was discovered that in many cases crazing developed on ware where the glazes were apparently free from strain or were in slight compression when the ware was removed from the kiln.

This discovery led to the belief that the body had probably expanded under normal atmospheric conditions, while the glaze and vitrified portion beneath it remained constant, thus producing tensional strains in the glazed surface tending to cause crazing. Tests were, therefore, conducted to determine this point and the results to date indicate this to be the case.

It was found that certain bodies expand as much as 0.1 per cent in length on storage while the glaze apparently remains constant and consequently cracking or crazing of the glaze develops. Bodies which do not develop this type of crazing do not show expansion on storage.

This increase in size of ceramic bodies is evidently due to combined water taken up from the atmosphere, and the amount of this water increases in proportion to the increase in volume of the bodies.

Different methods for testing this type of crazing were investigated, and the most promising one so far studied is the autoclave test. In this test it was found possible to produce in a few hours effects on the body and glaze similar to long periods of storage. The specimens to be tested are placed in an autoclave, partly filled with water, and heat is applied so as to produce a steam pressure of 150 to 175 lbs./in.^{2} for one hour. The specimens are then removed and inspected for crazing by applying a malachite green or similar solution to the glazed surface to intensify the appearance of the craze markings. If the glaze does not craze after the autoclave treatment, it is probable that it will not craze in the future because of an increase in volume of the ceramic body.

In general, the more vitreous bodies are less apt to develop this type of crazing than the more porous ones. It was

also found that bodies having low solubility in sulphuric acid do not develop crazing as much as those of higher solubility. In general, bodies having low ignition losses above 110° C. after three or more years' storage develop less crazing than those having a high ignition loss.

It was found possible to prevent this type of crazing from developing by adding fluxes, such as feldspar, to the body during the manufacturing process and firing the product in the kiln to a temperature where the body becomes thoroughly vitrified.

CASTING A DISK FOR A TELESCOPE REFLECTOR

The successful casting of a large disk of optical glass at the bureau was briefly described in the February number of the Bulletin. Some additional details may be of interest.

At first it was thought that this disk could be made by melting about 5,000 pounds of glass in one pot and cooling it in such a way that the pot would strip from the glass and leave the glass in one piece free from cracks. This procedure did not give satisfactory results.

Arrangements were then made to transfer the hot glass from the pot to a mold which would be at the same time an annealing furnace. The glass was melted in a pot specially prepared for this purpose at the bureau, and on May 7, 1927, the molten glass was transferred to the mold.

The mold consisted of a cast-iron base and lid each 85 inches in diameter and 2 inches thick, separated by a ring 81 inches in diameter, 2 inches thick, and 19 inches high. The bottom and sides of the mold were lined with a very friable brick. This assembly was placed on a compacted layer of powdered diatomaceous earth which served as a thermal insulator, and finally the entire assembly was covered with the same material 12 inches in thickness. Plates containing high electrical resistance wires were placed between the cast iron and the insulation in such a way that uniform temperature could be obtained, and the temperature of the furnace could be controlled by varying the amount of current flowing through the resistors.

The maximum temperature noted in any part of the furnace immediately after casting the glass was 1,000° C., and since there was no danger of the glass cracking at temperatures above 600° C. it was allowed to cool as rapidly as it would to this temperature, which was reached in about eight days. Then, by means of the electric heaters, this temperature was maintained for three days in order to obtain as uniform a temperature throughout the furnace as was possible. The glass was cooled slowly during two months from 600° to 460° C., at which temperature the glass was annealed for six weeks. Approximately five months were then required to reduce the temperature to that of the furnace room, and although the initial cooling rate from annealing temperature was approximately 1° per day it finally reached a maximum of 6° C. per day.

The furnace was uncovered on January 21, 1928, and when the glass was examined it was found to be perfectly satisfactory for the purpose intended, although it does contain some bubbles, striae, and some very small pieces of pot shell.

The disk in its present condition is approximately 70 inches in diameter, 11 inches thick, and weighs about 3,750 pounds. When the mirror is completed it will be 61 inches in diameter and 10 inches thick.

EFFECTS OF ACIDS ON LEATHER

An important problem confronting the leather industry is the effect of various acids on the life and properties of leather. There are two reasons why this problem has so far remained unsolved. First, there is a lack of definite knowledge as to the limiting values of acid which may be present in leather without harm; and, second, the methods for determining acid in leather are inadequate under some conditions. The use of new materials in making leather, some of which may possibly contain acid groups of harmful proportions,

makes the solution of this problem of great importance.

A realization of the present unsatisfactory conditions by the technical trade associations of the leather industry has resulted in the undertaking by the Bureau of Standards of a comprehensive research on the effect of acid in leather, the work being guided by an advisory committee from the industry.

The first part of the research program is now under way, and basic information has been secured on the effects of sulphuric acid on pure vegetable-tanned leathers. Standard leathers for this work were prepared in the bureau's experimental tannery with quebracho-wood extract and chestnut-wood extract, both of which are typical tanning materials. These leathers are free from oils, greases, sugars, and salts largely used in the finishing processes, and thus the action of the acid upon them will be free from possible acceleration or retardation by these materials. Samples of the leather have been treated with sulphuric acid so as to obtain specimens with amounts of acid varying from ¼ to 4 per cent. After determining the original strength and stretch of the leathers they were stored under controlled conditions of relative humidity and temperature.

Tests will be made periodically, extending over two years, on representative samples to note any deterioration in strength caused by the particular amount of acid present. Thus, information will be obtained on the effects of sulphuric acid on pure vegetable-tanned leathers. These data will serve as the basis for future investigations which ultimately will reveal the limiting amounts of sulphuric acid which may be present without impairing the value of the leather.

TENSILE PROPERTIES OF SOFT RUBBER COMPOUNDS AT HIGH AND LOW TEMPERATURES

Technologic Paper No. 364, which deals with the properties of rubber compounds over a range of temperature from —70° C. (—94° F.) to +149° C. (+300° F.), will be available for distribution in the near future. In this investigation six different rubber compounds were made and cured in thin sheets, after which rubber rings were cut out and tested in a specially designed apparatus. It was found that at very low temperatures rubber becomes stronger, but can be stretched hardly at all without breaking. At high temperatures the reverse is true. The rubber can be stretched a great deal without breaking, but has very little strength. At very high temperatures, however rubber not only loses its strength but loses its ability to stretch as well. It was observed that the extent to which rubber is affected by temperature varies according to the nature of the compound. The results show that the influence of temperature upon the properties of rubber is a feature which should be given careful consideration in the design of rubber articles which are to be used where they will become very cold or very hot.

When this publication is available, announcement, giving the price, will be made in the usual way.

STANDARD SIZES FOR UNDERWEAR

Considerable progress has been made on the standardization of sizes for knit underwear. This project is being carried on in cooperation with the Associated Knit Underwear Manufacturers of America through a research associateship at the bureau.

At a recent meeting of the standardization committee of the association Charles H. Hamlin, the research associate, presented for consideration, specifications for measurements and sizes of the following types:

1. Men's cotton ribbed knit athletic union suits (no sleeves, button shoulder, short leg).

2. Men's cotton flat knit athletic union suits (no sleeves, button shoulder, short leg).

3. Boys' ribbed (1 by 1) worsted, worsted-merino, wool, and wool-cotton union suits (made from fabric that has been washed in the roll and then cut and seamed).

4. Men's flat fleece union suits.

5. Boys' flat fleece union suits.

6. Women's ribbed (1 by 1) cotton union suits (high neck, long sleeve, ankle length).

On the recommendation of the committee these were adopted as standard by the association at its annual meeting. Few types of men's, boys', and children's remain for consideration. This was the first of the women's types to be adopted.

These standard sizes were considered by the Non-Military Wearing Apparel Committee of the Federal Specifications Board and were recommended to the board for comment and criticisms as a Federal Specifications Board specification. Previous to this favorable action by the committee, a complete range of sizes was furnished to the Navy and War Departments for trial at their depots. Favorable reports were received.

DENTAL RESEARCH AT THE BUREAU OF STANDARDS

The Bureau of Standards entered the dental research field in 1918, when a number of tests on dental amalgams were conducted at the request of the War Department. At that time, on account of the lack of sufficient funds, the bureau was not in a position to continue or extend the research to the other materials used in dental prosthesis, although the necessity for such work was clearly indicated.

On January 16, 1922, a cooperative research on these materials was entered into with the Weinstein Research Laboratories, of New York City. This research has been carried on in accordance with the plan[1] authorized by Congress on April 12, 1892, and March 3, 1901. The specific problems included in this cooperative program were announced to the profession in 1924.[2]

Numerous progress reports[3] on the individual items of this program have been issued as the data were secured. From these it will be seen that the object of the research—namely, to establish the physical properties of certain dental materials included within the scope of this program and methods for testing materials designed for similar uses which may be developed in the future—has been accomplished and the results given to the profession and to all others interested. Dental schools and testing laboratories may now select materials appropriate for the definite types of restorations and be assured of a safe method for manipulating the materials selected.

The cooperating laboratory has made it possible for the bureau to complete this work and, although the time required has been six years instead of two or three as anticipated in 1922, the Weinstein laboratories have never hesitated to maintain a sufficient number of research associates at the bureau and to bear their part of the expenses necessarily incurred. A conservative estimate of these items places the cost of the research to the cooperating laboratory at $50,000.

Recently when this research was being completed, the Weinstein laboratories expressed their willingness to prepare a new program to include additional items and problems of interest to the profession. In view of the most satisfactory

[1] Bureau of Standards Circular No. 296, "Research Associates at the Bureau of Standards." Available from the Superintendent of Documents, Government Printing Office, at 10 cents per copy.

[2] J. Am. Dental Assoc., **11**, pp. 249–250; March, 1924.

[3] Wrought materials, methods of testing, values, compositions, J. Am. Dental Assoc., **12**, pp. 509–516; May, 1925. Cast materials, methods of testing, values, compositions, Dental Cosmos, **LXVIII**, pp. 743–764; August, 1926. Selection of materials, casting to dimensions, need for testing, J. Am. Dental Assoc., **14**, pp. 189–199; February, 1927. Casting materials, physical properties, methods of testing. Dental Cosmos, **LXIX**, pp. 1007–1026; October, 1927. Analysis of dental gold alloys, methods of analysis, B. S. Sci. Paper No. 532. Price 10 cents. (Reprinted in J. of Dental Research, **VII**, December, 1927.) Dental gold alloys, tentative specification and test methods, J. Am. Dental Assoc. (In press; to appear in 1928.)

relations during the last six years it is certain that this work could have been successfully arranged and carried out in this manner, and the bureau very much appreciated this offer.

However, another proposition had also been received, from the American Dental Association through its research commission, and this was also given consideration. This organization, commending the work already done, offered to share expenses in the carrying on of the new research program. Inasmuch as this offer was made by the organized profession and at the time when the original program was completed, it appeared that this offer of cooperation rather than the one from the Weinstein laboratories should be accepted. Therefore, the bureau has decided to proceed in this manner, and the new research program will be carried on hereafter in cooperation with the American Dental Association. It is felt that this enlargement of the scope of the investigation is necessary and proper and that the burden of financing this cooperative program may appropriately rest upon the individuals for whose benefit the work is being carried on.

The bureau has, in fact, been in communication with the American Dental Association in regard to the matter of a cooperative research since September 27, 1921, but prior to 1928 the association has not seen its way clear to cooperate, financially, in this work.

The full cooperation of all parties interested in this new program is anticipated. Suggestions regarding the association's part in this work should be made through its research commission. Communications should be addressed to Dr. L. L. Barber, Toledo, Ohio, chairman of the special committee representing the American Dental Association in this research.

TESTS OF PIEZOOSCILLATORS

Tests of radio devices by the Bureau of Standards are necessarily limited to special tests for the Government, tests of instruments which are in turn used as standards for testing considerable numbers of other instruments, tests of importance to the bureau as a matter of research, and a few other tests for which special reasons arise.

The bureau has considered transmitting-station frequency standards as in the latter class, because of the great importance of insuring that all stations be adjusted to the same frequency basis, and because no laboratories doing commercial testing for the public have had standards or experience such as to insure that their measurements would meet this requirement. The demand for the testing of station frequency standards has increased to the point where the bureau can not meet the demand under its present appropriations and facilities. Pending the completion of testing at present on hand, the bureau must for the present put applications for test of station frequency standards on a waiting list. Such tests may be made subsequently as circumstances permit. The bureau may eventually discontinue the testing of station frequency standards entirely but does not expect to do this until it is satisfied that commercial organizations can handle the work satisfactorily. In the meantime the bureau desires to assist such organizations to prepare to do such testing.

The only kind of radio-frequency standard at present commercially available which can be relied upon to an accuracy better than 0.1 per cent is the piezooscillator. In the present state of development of this device, the bureau finds that the standardization of each one is a research job rather than a routine test. This has necessitated an increase in the fees charged; the new fees are given below.

A quartz plate will not be tested unless it operates readily, is mounted in a suitable holder, and is accompanied by the piezooscillator circuits in which it is used.

Some quartz plates submitted are unsatisfactory for certification by reason of failure to operate, having one or more frequencies close to the desired frequency, or having a frequency outside the 1 per cent limit set by the bureau.

In case this is ascertained before the complete procedure of adjusting the plate is carried through, schedule 163z applies; half of the regular fee is usually charged. In case the unsatisfactory condition does not appear until the adjustment procedure is completed, the entire fee will be charged. These fees will be charged independently of whether another plate is submitted later.

Item	Description	Fee
163a	Determination of one fundamental frequency of a piezooscillator or resonator or quartz plate, at room temperature	$15
163b	Determination of one fundamental frequency of a piezooscillator or resonator or quartz plate, provided with a suitable thermostat, at a specified temperature above that of the laboratory	25
163c	Adjustment at room temperature to specified frequency, of a quartz plate mounted in a holder provided with a simple mechanical adjustment for varying the frequency	20
163d	Adjustment at a specified temperature above that of the laboratory to specified frequency of a quartz plate provided with a suitable thermostat and mounted in a holder provided with a simple mechanical adjustment for varying the frequency	40
163e	Adjustment at room temperature to specified frequency, of a quartz plate cut to approximate frequency (not more than 1 per cent below the specified frequency)	30
163f	Adjustment at a specified temperature above that of the laboratory to specified frequency, of a quartz plate provided with a suitable thermostat and cut to approximate frequency (not more than 1 per cent below the specified frequency	75
163z	For special tests not covered by the above schedule, fees willl be charged dependent upon the nature of the test.	

RADIO SIGNAL TRANSMISSIONS OF STANDARD FREQUENCY, APRIL TO OCTOBER

The bureau announces a new schedule of radio signals of standard frequencies for use by the public in calibrating frequency standards and transmitting and receiving apparatus. The signals are transmitted from the bureau's station WWV, Washington, D. C. They can be heard and utilized by stations equipped for continuous-wave reception at distances up to about 500 to 1,000 miles from the transmitting station.

The transmissions are by continuous-wave radiotelegraphy. The signals have a slight modulation of high pitch which aids in their identification. A complete frequency transmission includes a "general call" and "standard frequency" signal and "announcements." The "general call" is given at the beginning of the 8-minute period and continues for about 2 minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letters (WWV) intervening. This signal continues for about 4 minutes. The "announcements" are on the same frequency as the "standard frequency signal" just transmitted and contain a statement of the frequency. An announcement of the next frequency to be transmitted is then given. There is then a 4-minute interval while the transmitting set is adjusted for the next frequency.

Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 171, which may be obtained by applying to the Bureau of Standards, Washington, D. C. Even though only a few frequency points are received, persons can obtain as complete a frequency meter calibration as desired by the method of generator harmonics, information on which is given in the letter circular. The schedule of standard frequency signals is as follows:

Radio signal transmissions of standard frequency

[Schedule of frequencies in kilocycles]

Eastern standard time (p. m.)	Apr. 20	May 21	June 20	July 20	Aug. 20	Sept. 20	Oct. 22
10 to 10.08	3,000	650	1,500	3,000	125	300	650
10.12 to 10.20	3,300	750	1,650	3,300	150	350	750
10.24 to 10.32	3,600	850	1,800	3,600	175	400	850
10.36 to 10.44	4,000	950	2,000	1,000	200	450	950
10.48 to 10.56	4,400	1,050	2,250	4,400	225	500	1,050
11 to 11.08	4,900	1,200	2,500	4,900	250	550	1,200
11.12 to 11.20	5,400	1,350	2,750	5,400	275	600	1,350
11.24 to 11.32	6,000	1,500	3,000	6,000	300	650	1,500

MEETING OF AMERICAN ELECTROPLATERS SOCIETY

The American Electroplaters Society held a meeting at the Bureau of Standards on March 2. The large attendance (85) was thoroughly representative and indicates the growing interest in technical research.

Dr. George K. Burgess, director of the bureau, gave a short address of welcome, in which he stressed the important advantages of cooperative research between the Government's scientific laboratories and the large industrial groups. He described the bureau's research associate plan and called attention to the fact that the electroplaters were among the first to see the advantages of this arrangement and have always given the bureau's work their hearty support.

"The Government itself is a large manufacturer," said Doctor Burgess. "The contacts made at a meeting such as this result in great benefits not only to you, but to the bureau, because we learn much about the practical side of electroplating from you. When we are asked for advice by other branches of the Government, which operate electroplating plants, we are better able to help them."

Following Doctor Burgess, Dr. W. Blum, in charge of the bureau's electrochemistry section, traced the history, present developments, and probable future research work in electrodeposition. He explained that in the cooperative work in this field the expenses have been about equally divided between the bureau and the cooperating organizations. Results have been published and improved methods quickly put into practice. The question of personnel is a serious one, since trained men are hard to find, and those who have become valuable to the bureau often leave to accept the higher salaries which the industry can pay. The turnover in the electrochemistry section is about 50 per cent per year. However, these men go out and preach the gospel of industrial research, so there are some advantages in holding them at the bureau for only about two years.

Doctor Blum then started a discussion of various electroplating problems, in which many delegates took part.

Reports on researches in progress were then presented, followed by a short inspection of the laboratories and lunch in the Industrial Building.

The afternoon session was occupied by a report of the society's research committee and by a discussion of future work. The final recommendations of the conference will be published in the technical press.

PUTTING SIMPLIFICATION TO WORK

All engineers and designers do not concur in the belief that complete standardization would be an ideal condition in the mechanical industries. They are more nearly of one mind, however, in agreeing that there is a practicable middle ground where all interests could meet without sacrificing individuality of design.

They believe that such harmony of thought would bring about elimination of those sizes and dimensions of machine parts which can be spared. Such action would not imply that the industry feels obliged to effect an arbitrary reduction merely for the sake of struggling along with less than its former variety.

The first step in machine design is usually the calculation of the mechanical advantage of the proposed assembly, from a strictly technical standpoint. At this stage the cost of its manufacture and the price which will be exacted for its ownership and maintenance are secondary considerations. Ultimate efficiency, however, must be expressed in dollars and cents rather than in technical excellence. Consistent economy, therefore, bids us temper our respect for mechanical advantage with a due regard for commercial advantage.

Many executives and engineers in the mechanical industries now appreciate that it is practicable to apply the principles of simplification, familiar in individual operations, to whole industries. This group action solves problems and effects benefits impossible through isolated or sporadic effort.

By putting simplification to work manufacturers, distributors, and users of machines secure a very real commercial advantage over certain resistances to the successful conduct of business in an industrial era that is becoming more and more complex.

LUMBER SURVEY IN NORTH CAROLINA

As another step in the elimination of waste in industry, a survey of nonutilized wood, available as raw material for by-products industries, will be undertaken in North Carolina by the National Committee on Wood Utilization, of the Department of Commerce. A similar survey of Virginia is now nearly completed. This series of State surveys, planned to eventually cover the entire country, is part of the committee's program of closer use of wood to enable profitable commercial reforestation.

LUMBER FOR OIL DERRICKS

In making changes in its specifications the American Petroleum Institute, division of standardization, included the notation that structural lumber used for reinforcing legs in A. P. I. steel derricks shall be new and shall conform to the requirements of the American lumber standards for select or dense select grades, as given in Simplified Practice Recommendation No. 16.

ARMY MEN REPORT TOO MANY TIRE SIZES

Army motor transport officials visited the automobile show in New York to inspect the latest advances in mechanical transportation. While the unprecedented variety of brilliant colors, the style and grace of body, the quietness of the motor, and the improved riding qualities did not go unnoticed, the Army men were quick to express unfavorable comment regarding the great variety of tire sizes shown. Each year has seen manufacturers of motor cars getting farther and farther away from standardization. Wheels seem to be getting smaller and smaller with each new year's models, and soon no tire dealer can hope to carry in stock the variety of sizes required as replacements.

In discussing the subject, the Speedometer, official camp paper at Camp Normoyle, Tex. (February, 1928), said that the Army must eventually purchase these new vehicles for military use and that the tire situation is already causing concern in this quarter.

SIMPLIFIED INVOICE FORM

Approval of the simplified invoice form has been given by the Committee on Purchases and Stores Engineering Association, which recommended its indorsement by the American Electric Railway Association. The report states that the purchasing and accounting departments should favor the general adoption of this invoice by suppliers, because, by providing definite places for the insertion of all the essential data required by any buyer, it simplifies the work of handling, checking, and auditing invoices; that railway purchasing agents could further the use of the form to a great extent by requesting sellers to render invoices on the simplified invoice.

Not only has the Purchasing Agents Association indorsed the simplified invoice, but it has urged each member to give his active assistance in developing adherence to the form. The March meeting of the various chapters of the association will be known as "Simplified Invoice Night." Speakers on the standardization of office systems will compare the present loose-leaf system with the old heavy cumbersome bound books and will show how the simplified invoice is the furtherance of the idea behind the loose-leaf method.

STANDARD SIZE OF MAGAZINES

During the past two years more than 20 publications, all members of the Associated Business Papers (Inc.), have adopted the standard type page size for their respective publications. The standard page is 7 by 10 inches. Recently the Iron Age announced that it had adopted the standard type page size but would not change the over-all size of the publication until about July 1, 1928,

when it would adopt the size 9 by 12 inches.

ACTIVITIES OF COMMERCIAL STANDARDS GROUP

Inks and Adhesives.—A preliminary meeting of manufacturers was held in New York on February 14. A simplified practice committee was appointed to develop a program for reduction in the line of inks and adhesives.

Adhesive Plaster and Surgical Gauze.—At a general conference held in New York on February 15 recommendations for these commodities were approved. The industry will be circularized for acceptance.

Pyroxylin-Coated Fabrics.—A preliminary meeting was held in New York on February 28 to consider the application of simplified practice to this industry.

Fire Engines.—A preliminary conference was held in Cleveland, Ohio, January 25 under the auspices of the Fire Equipment Institute. The conference was attended by representatives of the National Board of Fire Underwriters and the division of simplified practice. A committee was appointed to study simplification of fire-engine capacities.

Hack-Saw Blades.—The simplified practice committee of the Hack Saw Manufacturers Association of America recommended a simplified list of sizes, which was unanimously adopted at a meeting held in New York on January 25. The manufacturers have requested the division of simplified practice to call a general conference of the industry as early as possible. Conference invitations and agenda are being prepared and the latter approved by the manufacturers. A general conference is scheduled for the last week in March.

Rubber Soles and Heels.—Reduction in variety of grades and qualities was taken up at meeting of the heel and sole division of the Rubber Association of America in New York on January 24. Herbert A. Derry was appointed chairman of the simplified practice committee.

Ice Cakes and Ice Cans.—A meeting of the simplified practice committee of the refrigeration industries was held in Detroit, Mich., on January 31, to consider completed surveys of demand for both items. A recommendation covering a simplified list of sizes for both items was formulated and submitted to the National Association of Ice Industries, the Refrigerating Machinery Association, and manufacturers of ice cans for approval. George B. Bright, president of the American Society of Refrigerating Engineers, is chairman of the simplified practice committee, and suggests holding a general conference in March.

American Marine Standards Committee.—Proposed standards have been submitted to the subject committee on joiner hardware, etc., covering rim locks and mortise locks for ship doors. The subject committee on rules for boilers and pressure tanks held a meeting for further discussion of proposed standard rules for design and construction of marine boilers. Agreement was reached as to the form of proposed rules, leaving only a number of details to be adjusted by a special committee. At the same meeting the committee tentatively approved proposed standard specification for marine boiler steel plates, subject to minor adjustments.

A proposed final draft of standard specification for metallic packing for condenser tubes was submitted to the technical committee on engineering details.

Proposed standard specifications for propellers, and instructions for making templates for propeller blade flanges and bolt holes were prepared and submitted to the subject committee on shafting, etc. Considerable progress was made toward completion of proposed standards for:

Pipe flanges.

Table glassware.

Scupper valves.

Final drafts of specifications for insulation of piping and machinery.

Final drafts of specifications for several types of hose.

Proposed standards for various types of door bolts.

Steps are in progress to organize a subject committee to study the possi-

bility of standardizing water-tight receptacles for use on shipboard to obtain interchangeability of various types on the market.

Clinical Thermometers.—At a preliminary conference held in New York on February 24 the manufacturers of clinical thermometers accepted a very rigid specification for these instruments and requested the services of the Bureau of Standards for the establishment of this specification as a commercial standard for the industry. A general conference is scheduled for March 30 in Washington, to which all those interested in clinical thermometers are invited.

Porcelain Plumbing Fixtures.—A dimensional survey for porcelain plumbing fixtures has been completed and reports mailed to interested manufacturers. A conference will be held in Washington this month, and it is expected that a general conference will follow at an early date to establish a commercial standard for this commodity. Grading rules for this commodity dated January 16, 1928, accepted in writing by 100 per cent of the producers, have been distributed to 1,200 wholesalers of plumbing goods throughout the United States. It is planned that these grading rules will also become a part of the forthcoming commercial standard.

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1927).

Scientific Papers [4]

S567. Some principles governing the choice and utilization of permanent-magnet steel; Raymond L. Sanford. Price, 5 cents.

Volume 21, Scientific Papers of the Bureau of Standards; Nos. 524 to 546 (bound in cloth). Price, $2.

[4] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

Technologic Papers [4]

T349. Physical properties of the principal commercial limestones used for building construction in the United States; D. W. Kessler and W. H. Sligh. Price, 30 cents.

T359. A superheat meter or differential thermometer for airships; D. H. Strother and H. N. Eaton. Price, 10 cents.

T361. Deterioration of steels in the synthesis of ammonia; J. S. Vanick, W. W. de Sveshnikoff, and J. G. Thompson. Price, 15 cents.

Title page and index for volume 21 of Technologic Papers, Nos. 328 to 352, inclusive (free on application to Bureau of Standards).

Circulars [4]

C13 (11th ed.). United States Government Master Specification for lamps, electric, incandescent, large, tungsten filament. Price, 5 cents.

1928 Supplement to C13 (11th ed.). 1928 supplement to United States Government Master Specification for lamps, electric, incandescent, large, tungsten filament.

Supplementary List of Publications of the Bureau of Standards, July 1, 1925, to June 30, 1927 (free on application to the Bureau of Standards).

Supplement to Circular No. 25. Standard samples issued or in preparation (free on application to the Bureau of Standards).

Handbooks [4]

H3 (4th ed.). National Electrical Safety Code (cloth bound). Price, $1.

Simplified Practice Recommendations [4] (Elimination of Waste)

R17 (1st rev.). Forged tools. Price, 5 cents.

R48 (1st rev.). Shovels, spades, and scoops. Price, 5 cents.

[4] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

R60. Packing of carriage, machine, and lag bolts. Price, 5 cents.

Miscellaneous Publications [4]

M90 (2d ed.). Directory of commercial testing and college research laboratories. Price, 15 cents.

Technical News Bulletin [4]

TNB131. Technical News Bulletin, March, 1928.

OUTSIDE PUBLICATIONS [5]

Electric mantel clocks. R. E. Gould; Jewelers' Circular (New York, N. Y.), Vol. 96, No. 4, p. 367; February 23, 1928.

An interpretation of the A. S. T. M. distillation curves of motor fuels. Oscar C. Bridgeman; Bulletin, American Petroleum Institute (New York, N. Y.), Vol. IX, No. 7, p. 54; January 31, 1928.

The lean explosive limits of cracked and straight run gasolines. D. C. Ritchie; Bulletin, American Petroleum Institute (New York, N. Y.), Vol. IX, No. 7, p. 69; January 31, 1928.

Some factors in engine acceleration. R. Best and J. O. Eisinger; Bulletin, American Petroleum Institute (New York, N. Y.), Vol. IX, No. 7, p. 74; January 31, 1928.

A detonation survey. H. K. Cummings; Bulletin American Petroleum Institute (New York, N. Y.), Vol. IX, No. 7, p. 81; January 31, 1928.

Testing tank car valves. D. V. Stroop; Bulletin, American Petroleum Institute (New York, N. Y.), Vol. IX, No. 7, p. 193; January 31, 1928.

Determination of sulphur in volatile fuels. H. T. Kennedy; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 20, No. 2, p. 201; February, 1928.

A study of 129 Lovibond red glasses with respect to the reliability of their nominal grades. B. D. Judd and G. K. Walker; Oil and Fat Industries (New York, N. Y.), Vol. V, No. 1; January, 1928.

Methods of measuring ultra-violet radiation. W. W. Coblentz; Radiology (St. Paul, Minn.), Vol. X, p. 116; February, 1928.

Recombination spectra of atomic ions and electrons. F. L. Mohler; Physical Review (Corning, N. Y.), Vol. 31, No. 2, p. 187; February, 1928.

Purification of the six platinum metals. Edward Wichers, Raleigh Gilchrist, and William H. Swanger; American Institute of Mining and Metallurgical Engineers (New York, N. Y.), Technical Publication No. 87; March, 1928.

Effect on combustion and efficiency of replacing the grid of an open-top gas range with an attachable solid top. J. H Eiseman; American Gas Journal (New York, N. Y.), Vol. 128, p. 27; February, 1928.

Sound insulation. V. L. Chrisler; Architecture (New York, N. Y.), Vol. LVII, No. 2, p. 87; February, 1928.

The strength of solid and of hollow walls of brick. A. H. Stang; Architect, Builder and Industrial News (Newark, N. J.), Vol. 4, No. 7, p. 141; February 15, 1928.

Strength of brick in tension. J. W. McBurney; Journal, American Ceramic Society (Columbus, Ohio), Vol. 11, No. 2, p. 114; February, 1928.

Further studies on Portland cement compounds by the X-ray diffraction method. W. C. Hansen; Portland Cement Association fellowship (Bureau of Standards, Washington, D. C.), Paper No. 12; February, 1928.

Expansion of a calcined gypsum on setting. J. A. Murray; Rock Products (Chicago, Ill.), Vol. 31, No. 2, p. 88; January 21, 1928.

Composition of commercial chemical limes. J. S. Rogers; Rock Products (Chicago, Ill.), Vol. 31, No. 3, p. 60; February 4, 1928.

Workability—a symposium. George A. Smith and George Conahey. Presented at annual convention of and published by American Concrete Institute, Detroit, Mich.; February, 1928.

[4] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

[5] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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